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# Technical Report

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GENERATING

VEHICLE

GRAPHICS

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report describes an efficient method of generating vehicle garphics for use in Dynamic Analysis & Design System (DADS) animations on the VAX 730 computer, using the Lexidata Solidview device, the program MOVIE.BYU and several system programs written to complement it.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

## 1.0. INTRODUCTION

This report describes the conventions and step-by-step procedures to be followed in order to generate vehicle graphics using a program called MOVIE.BYU, a Lexidata device, and the VAX 730 computer. It is subdivided into the following sections:

- Conventions
- Creating graphics parts
- Assembling vehicles
- Animating vehicles

## 2.0. OBJECTIVE

The primary goals of this report are to allow someone with a limited knowledge of the software involved, to reproduce existing vehicle graphics and even create their own. It is recommended that, before attempting to create vehicle graphics of their own or even reproduce vehicles from existing documents, the user do the following: thoroughly study this report, read at least the relevant sections of the MOVIE.BYU documentation, and review the file of specifications for vehicle graphics already created.

## 3.0. CONCLUSIONS

Using this report and existing vehicle documentation, anyone with a basic understanding of the equipment and software required (the Lexidata device, the VAX 730 computer, and MOVIE.BYU) can reproduce vehicles already created, and create and document their own vehicle graphics.

## 4.0. RECOMMENDATIONS

Some additional graphic aids should be made available. Possibilities include a library (database) of vehicle parts and a graphics editor.

## 5.0. DISCUSSION

### 5.1. Conventions

5.1.1. Origin. Using drawings of the vehicle, an origin must be selected. It should be even with the point furthest forward on the vehicle, the lowest point on the vehicle, and in the center of the vehicle (left to right). In other words, looking at a left side view of the vehicle, the origin should be in the lower left corner of the drawing, halfway into the page.

5.1.2. Axes. In the interest of consistency, the axes should always be oriented in the same way relative to the vehicle. The use of a right-hand coordinate system is generally accepted. The positive X axis should be toward the rear of the vehicle, positive Y toward the right side, and positive Z toward the top. In other words, looking at a left side view of the vehicle, the positive X axis is to the right, the positive Y is into the page, and the positive Z is up.

5.1.3. Coordinates. The coordinates of all points are, by convention, measured in inches.

## 5.2. Creating Graphic Parts

5.2.1. Normal parts. To create most parts, the MOVIE.BYU program [USER]UTILITY is used. First of all, GEOMETRY CHANGE (only the first four letters of commands are required, so GEOM CHAN will suffice) must be entered. This invokes the mode in which changes can be made to the geometry file being created. The next command to be entered is COORINATE (COOR). This invokes a prompt asking for the number of nodes (points) to be created. A cube, for example, would be made up of eight nodes. More complex shapes require more nodes. The X,Y,Z coordinates (inches) must then be entered for each node. The next step involves typing ELEMENT (ELEM) after returning to GEOM CHAN made by hitting RETURN once. This returns a prompt for the number of nodes per element. A cube would have four nodes per element; more elaborate shapes would have more.

The next prompt asks if the elements are to be added, deleted, or replaced. Simply enter ADD (A) in answer to this query. The group number (1) and the nodes to be included in the element are then entered. The nodes should always be entered according to the right-hand rule (using a right-hand coordinate system). According to this rule, the nodes are to be entered in a counterclockwise order when viewing the element from the outside. This correlates to having the thumb of the right hand facing outward and listing the nodes in the order indicated by the direction the fingers are curling (counterclockwise).

5.2.2. Curved parts. When creating circular or cylindrical parts, another method is required. This involves a different mode of [USER]UTILITY, MAKE VOLUME REVOLVE (MAKE VOLU REVO). This method consists of defining a two-dimensional shape in the X-Y plane, and then revolving it around the X axis. The first prompt to be answered (simply hit RETURN for extraneous prompts) requests the number of nodes on the shape to be created and the angle it is to be revolved. Four nodes rotated 360 degrees would be used to form a solid cylinder, such as an axle. More nodes are required to form more complex parts, but 360 degrees is the standard revolution for solid parts. The X, Y, Z coordinates (inches) of each node are then entered.

The next prompt to be answered asks for the number of circumferential elements (elements around the circumference of the circle) to be created. This parameter determines the smoothness of the curve to be formed (12 to 16 elements will form a fairly smooth curve). Using too many elements will unnecessarily slow the actual drawing of the part, while using too few will cause the curve to look jagged. A compromise must be reached, depending on the size, shape, and importance of the part.

5.2.3. Saving geometry files. After creating a part using either of the two methods just mentioned, the geometry file must be saved. This is done by changing to the GEOMETRY WRITE (GEOM WRIT) mode. The program will then prompt for the geometry filename. After choosing a name, the program may be terminated by entering EXIT.

## 5.3. Example Parts

5.3.1. The following is a step-by-step example of the creation of a simple part using UTILITY in the GEOM CHAN mode. The part to be created is a basic cube. The first step is to run the program by entering RUN [USER]UTILITY, and then GEOM CHAN COOR. The number of nodes to be entered is 8, as follows: 1 0 0 0, 2 0 0 2, 3 2 0 2, 4 2 0 0, 5 0 2 0, 6 0 2 2, 7 2 2 2, 8 2 2 0. The elements must be defined next, each consisting of four nodes. They are part of group 1, and are entered as follows: 1 4 3 2 1, 1 5 6 7 8 , 1 1 2 6 5, 1 2 3 7 6, 1 3 4 8 7, 1 4 1 5 8. GEOM WRIT is entered next, the file being named A.GEO. Pictures of this part, both in the draw mode showing the nodes and in view mode showing it as a solid, are contained in Figures 5-1 and 5-2.

5.3.2. The following is an example similar to the one above describing a cylindrical shape. After running [USED]UTILITY, MAKE VOLU REVO is entered. Four nodes are to be used and the shape is to be revolved a full 360 degrees. The four nodes are then entered as follows: 0 0 0, 0 0 6, 3 0 6, 3 0 0. The only other prompt to be answered is the one requesting the number of circumferential elements, 16. This part must also be saved by entering GEOM WRIT, the file being named B.GEO. Pictures of this part in both modes are in Figures 5-3 and 5-4.

## 5.4. Assembling Vehicles

5.4.1. Rotating parts. Once the geometry file of a part is completed, it is often necessary (especially for parts made using MAKE VOLU REVO) to orient it properly with respect to the axes. This is done by using a program called [USER]ROTATE. This program prompts first for the input and output geometry filenames, which must be supplied. The next step is to input the angles of rotation about the X,Y,Z axes. For example, a tire created using MAKE VOLU REVO which is about the X axis would, when rotated 0(X) 0(Y) 90(Z), be about the Y axis--properly oriented to be put on a vehicle.

5.4.2. Translating parts. Once they are created and oriented correctly, parts must often be translated (moved) to their proper positions relative to the rest of the vehicle. This process is performed using a program called [USER]TRANSLATE. This program also prompts for input and output geometry filenames. After these are entered, the program prompts for the translation amounts (inches) along the axes by the proper amount. For example, inputing 10 0 12 would move the entire part 10 inches toward the rear of the vehicle (along the X axis) and 12 inches up (along the Z axis.).

5.4.3. Merging parts. Once all of the parts required to form a vehicle are created and placed in the correct orientations and positions, they must be combined. In order to keep the number of parts to a reasonable figure, it is often desirable to combine several similar parts to form one larger part. This is accomplished using [USER]MERGER to merge the geometry part files into one larger geometry part file. The program prompts for a command, the proper response being MERGE. It then prompts for the input filenames (% halts this process) and, finally, the output filename. A filename without an extension should be used, since MERGER creates three files with extensions .GEO, .INF, .BOD. The MERGER program will create a new geometry file containing the coordinates and elements of the merged parts. It will, however, still consider the component files to be separate parts.

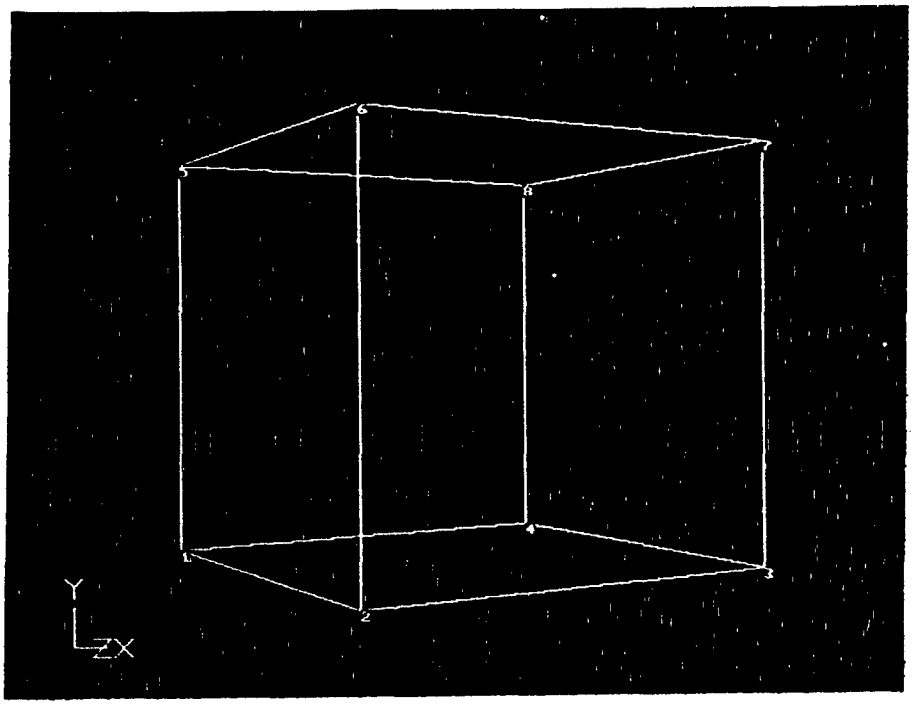


Figure 5-1. Draw Mode Picture of Cube (Observe numbered nodes)

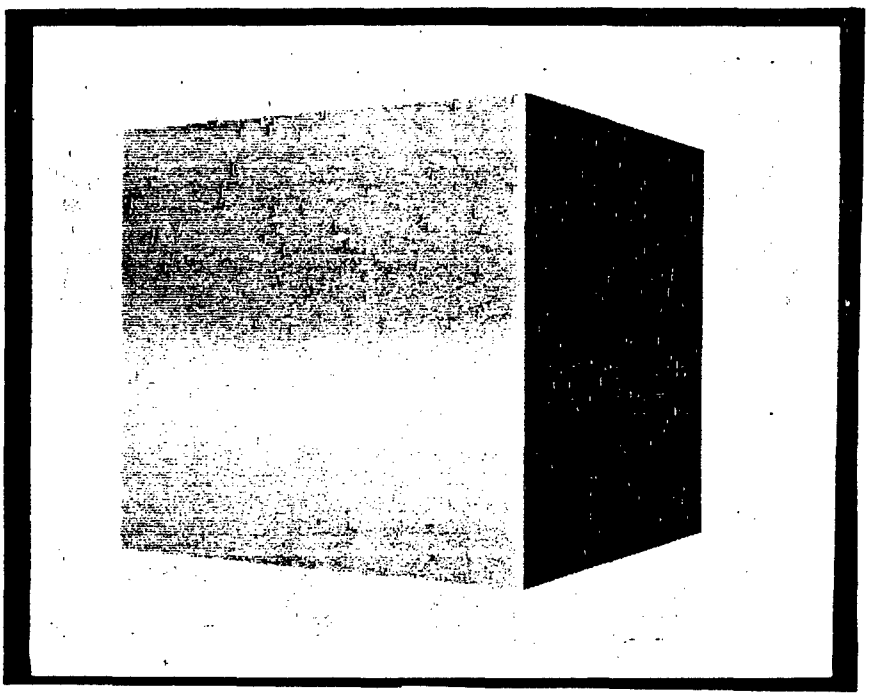

Figure 5-2. View Mode Picture of Cube

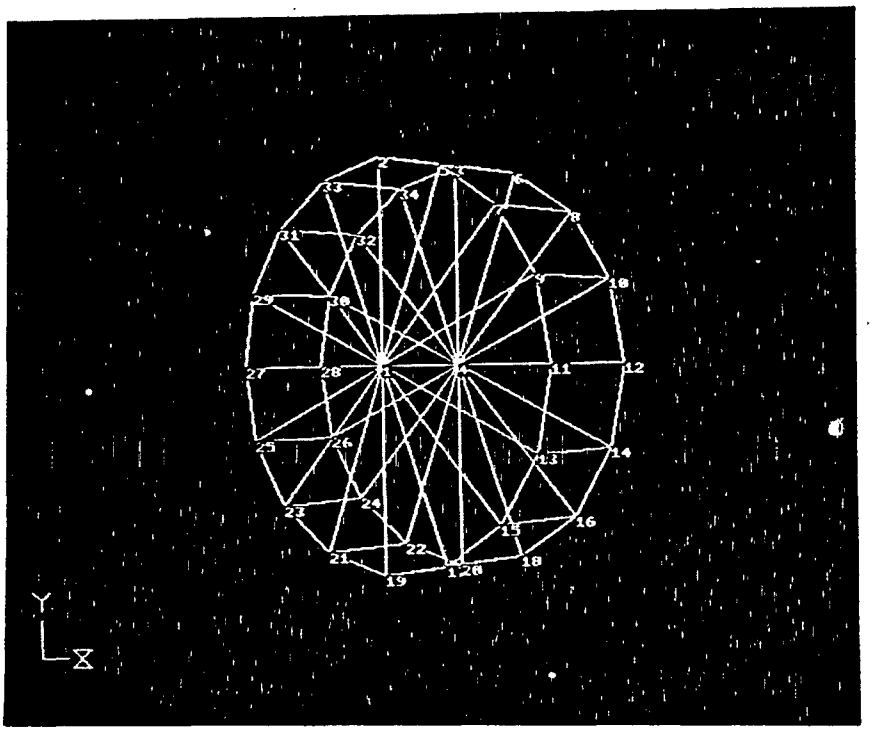


Figure 5-3. Draw Mode Picture of Cylinder

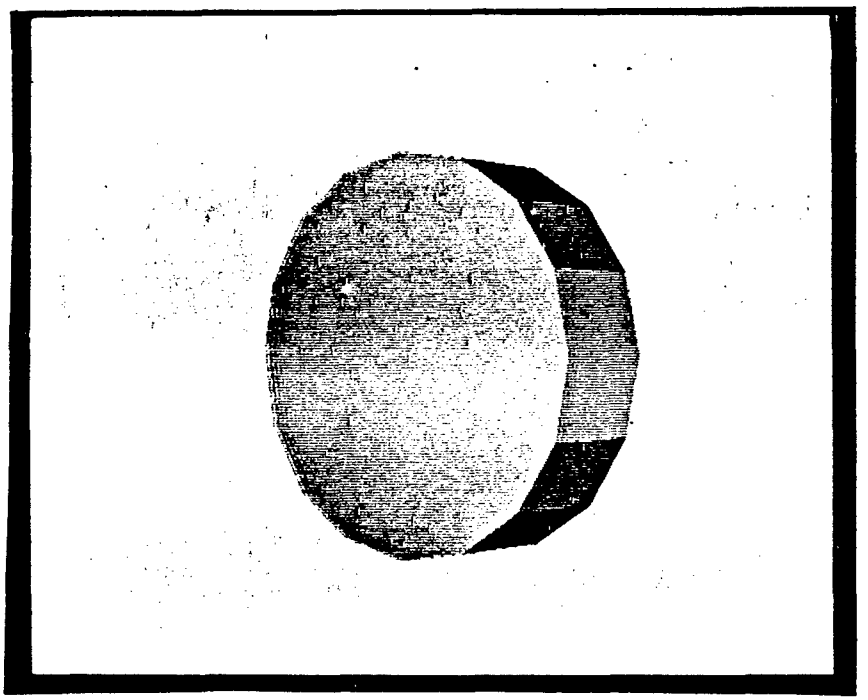

Figure 5-4. View Mode Picture of Cylinder

To modify this, UTIITY must be used once again. The GEOMETRY READ (GEOM READ) mode must be used and the filename entered. The program will then prompt <CHANGES?>. A response of YES or Y will return a prompt asking CHANGE NUMBER OF PARTS?, the proper response being YES or Y. The next prompt will say NUMBER OF PARTS. A response of 1 will return a prompt asking for the number of elements, which should have been printed on the screen when the geometry file was read into UTILITY. The geometry file should then be saved under a new name. Once the total number of parts is at a reasonable figure (usually less than 20) the actual vehicle file may be formed. This is done using MERGER again, simply inputing the parts' filenames to create one large file.

## 5.5. Animating Vehicles

Animating the vehicle itself is the final step of the process. This report, however, is intended primarily to describe the process of creating vehicle graphics, not the actual animations. For this reason, the animating program, ANIMATE2, will be touched on only briefly here. The program prompts for geometry, body, and Dynamic Analysis and Design System (DADS) filenames (the creation of DADS files is beyond the scope of this report), which must be supplied. Other parameters to be entered are: COLOR (choose three color components, Red, Blue, Green between 0 and 1 for each part), DISTANCE (choose distance from origin in inches), LIGHT (choose location of light source), and ROTA (choose rotation angles about three axes for entire vehicle). The command VIEW is then entered to view the vehicle. If the vehicle is all in order, then the command ANIM is entered to begin the animation sequence.

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